Attachment 2

Blanchard Beach Wetland Restoration
Feasibility Analysis (Outline Form)

FINAL 2-17-12 Final recommended actions highlighted

Feasibility Analysis Looks at Various Options

Options Cover Five Categories

Treatment of Primary Stream Water Quality at Wetland (A Options)

First feasibility question is whether to treat the water quality of the existing stream flow as it enters the Blanchard Beach wetland. Based on the watershed analysis, there recently was a visible sediment discharge to the stream observed at the pipe outfall below Lake Forest Condominiums. This pipe carries drainage from the larger eastern/southeastern portion of the watershed. See discussion under next section. The small stream draining the central portion of the watershed containing most of the condominium projects was clear. The western portion of the watershed flowing through Oakledge Park enters the wetland at a separate point and is addressed separately below.

A primary issue with treating the water quality of the entire stream flow is whether stream can be safely obstructed or diverted for treatment. Vermont Fish & Wildlife (F&W) conducted a quick fisheries assessment and found a small but viable fisheries in the stream up to the Lake Forest Condominiums. This fishery may be self sustaining, as well as being tied to Lake Champlain. F&W requested that no obstruction of the stream occur, and was skeptical of any "first flush" diversion structures that might be added to the stream, whether inside a structure or in the stream channel.

See discussion of the options considered below.

Management of Upper Basin Land Uses to Improve Stream Water Quality (B Options)

Second feasibility question is whether to reduce stormwater pollutant loads to the stream by actively managing land uses higher in the watershed, particularly in sub-watershed areas identified as contributing to the pollutant loads.

Based on a recent watershed survey, sub-watershed areas CSWD-1, AP-1, and IPW-1 in the eastern portion of the watershed, and sub-watershed areas OLP-2 (in Oakledge Park) and FA-1 and FA-2 (along lower Flynn Ave.) have the greatest potential for pollutant contributions and are not currently subject to state stormwater permits. See cross hatching on Watershed Map.

Sub-watershed area AP-1 contains a trucking company's staging areas including extensive impervious areas including compacted earthen yard areas and other commercial activities that are not subject to stormwater permits. The preliminary assessment is that this area is a prime candidate for stormwater management to reduce pollutant loading to the stream.

Sub-watershed area OLP-2 contains the lower parking area for the park which has a compacted earthen surface. It also contains a drainage channel along the lower park road that has a chronic problem with scour. This area is addressed as part of the D Options below.

See discussion of the options considered below.

Treatment of Drainage from Lower Flynn Avenue (C Options)

Third feasibility question is how to treat the stormwater that currently flows from lower Flynn Avenue into the Blanchard Beach wetland. Recently, with the construction of the Flynn Avenue sidewalk, all flows were directed to a catch basin near the park entrance that discharges into zone 1 of the wetland. A small stone forebay has been added to provide some level of pre-treatment. Treatment otherwise is provided by flow over the wetland soils, which are nearly bare because of the lack of sunlight.

The primary question is whether to continue treating this stormwater in zone 1 or to divert most of it to a separate treatment area in zone 3 (east end) where drainage formerly flowed before the sidewalk was constructed. This would free more treatment capacity in zone 1 for drainage from Oakledge Park.

See discussion of the options considered below.

Treatment of Drainage from Oakledge Park (D Options)

Fourth feasibility question is how to treat the stormwater that currently flows from Oakledge Park. Drainage from the upper reaches and both parking lots flows through a swale along the entrance road, through a right angle culvert at the park entrance, then back in a swale to the dilapidated stream inlet structure above the wetland.

Drainage from the entrance road area flows separately along the pavement and island and then splits at the corner with Lower Flynn, with most of the drainage flowing through the Lower Flynn catch basin into zone 1 of the wetland. Some of the remaining drainage flows over the pavement around the corner and into the swale feeding the dilapidated inlet structure above the wetland. This appears to occur mostly during larger storm events.

Currently, it appears that the drainage from the upper reaches of the park, including the upper paved parking lot, does not suffer from sediment discharges and receives favorable water quality treatment in several small wetlands, brush areas, and grass lawns.

The lower unpaved parking lot has an earthen surface that contributes sediment to the lower swale and to the stream, as evidenced by accumulated sediment at the lower end of the parking lot and discoloration of drainage.

The lower drainage swale along the entry road has chronic problems with scour caused by high flow velocities and inadequate vegetation or armoring. Recently, an active headwall gully was located just below the point where the drainage from the upper reaches enters the swale. The City has recently added stone to the swale in an attempt to reduce the sediment scour.

Sometimes during winter periods, this swale is inadequate and overflow freezes on the exit road.

The primary question is whether to split the drainage between the upper and lower reaches, and direct the relatively clean upper reach drainage directly to the stream and use the zone 1 wetland treatment area only for drainage from the lower parking area and entry road. One area could be directed into a new pipe while the other area could use a reconstructed swale.

Or, should the drainage remain mixed and use a flow splitter to treat as much drainage as possible in zone 1 of the wetland and divert the overflow to the stream.

The secondary questions are whether to armor the lower parking lot and/or use a swirl separator to pre-treat the drainage, and how to armor the swale along the entrance road.

Extent of Wetland Restoration/Stormwater Treatment (E Options)

Final feasibility question is selecting the optimum volume of water quality treatment that can occur within wetland zone 1. All the options can use excavation of accumulated sediment within five small pools that provides about 775 cubic feet of storage.

The greater question is whether to use an earthen berm along the streamside edge of this zone to isolate the wetland treatment pools from stream overflow and to sequester a larger water quality volume for a longer time within this zone. Such isolation of wetland stormwater treatment areas is recommended in the most recent research on constructed wetlands (see Virginia study). Such a berm could be created by placing bolders and large stone along the outside edge (stream side) of the berm and backfilling the berm with excavated soils from the wetland pools and additional sources if needed. Work could be done with hand wheel barrows or with small scale mechanized equipment operating on wood planks to minimize soil compaction.

Adding a berm along the southern edge of the stream raised some concerns with F&W, although they did not rule it out. The larger the berm, the greater the perceived impact by F&W and the public.

City to Pick One Numbered item from Each Category

Within each of the above categories, several options exist and are listed and numbered below. Those options that do not have clear obstacles and are recommended for more in depth consideration are also underlined.

These options recommended for in depth consideration are then evaluated in a decision matrix (see attached) against five factors: technical feasibility, regulatory/environmental issues, water quality benefits, construction cost, and public perception. For each factor, a score of 1 through 4 has been assigned (and can be considered by the City) with 4 being most favorable and 1 being least favorable. A color is also assigned to each score (green = 4, yellow = 3, orange = 2, red = 1).

For any factor that scores less than 4, a note is added to summarize the limitation for quick reference. The narrative below for each option also discusses many of these limitations.

Finally, the consultant team is providing its recommended option(s) for each category. In most cases it is the highest score, but some professional judgment has been applied as well, as discussed below.

In the next section, for each numbered option, a discussion follows as to the nature of the option considered and the major positive and negative factors to consider. In reviewing these options, reference should be made to the attached concept plans. One shows all options considered for reference, while the other two reflect only the final recommendations for clarity. The plans are divided into two sheets, one for the wetland area and one for the lower parking area. Reference should also be made to the Draft Subwatershed Map and Table of Water Quality Volumes and Pollutants for various sub-watershed areas in Oakledge Park and Lower Flynn Avenue.

A Options for Treatment of Stream Water Quality Volume at Wetland

1 On-Stream Treatment (basin = 15,000 sf & max 35,000 cf), Replace Inlet Structure

This option would consist of adding a control structure below the wetland (at the bike path culvert) to regulate stormwater flow and utilize the entire wetland basin as a detention basin with a large water quality volume to settle out sediment and other pollutants. The inlet structure above Flynn Avenue would also be replaced.

As such a structure would block fish movement to and from the lake, it was not considered further, regardless of its potential water quality benefits. It would also have faced a rigorous review by the Corps of Engineers (COE) because of the magnitude of impact to the wetland (upwards of 4 feet of water over 15,000 sf).

Note, most of the same problems would exist if this option was sized only as an on-stream "forebay" and located at the upper end of the wetland. So this sub-option was also not considered further.

2 Off-Stream Treatment (see Option E), Replace Inlet Structure

This option would consist of replacing the inlet structure above Flynn Avenue and adding a first flush diversion device that would pass base flow, but divert the first flush of stormwater into a portion of the wetland for water quality treatment (see Options E1- E3). This could alternatively be accomplished with a small diversion dam and pipes on the stream channel just inside the wetland.

Aside from the technical complexity of such an on-stream devise, the potential water quality volume was deemed to exceed the available capacity of the feasible wetland treatment in zone 1 (see Options E1-E3) which can also serve drainage from Lower Flynn Avenue (see Options C1-C4) and Oakledge Park (see Options D1-D12). F&W was also skeptical regarding whether such devises would not interfere with the fisheries. Therefore, this option was not considered further.

<u>3 Floodplain Treatment (zones 2-4 = 1,700 sf & 600 cf), Replace Inlet Structure</u>

This option would consist of excavating accumulated sediment from portions of the wetland in zones 2, 3, and 4 to create shallow pools and enhanced wetland communities. Excavation would occur by hand and would be up to 12 inches deep. The intent is that during early stages of larger storm events, the stream will overflow into these shallows and provide some level of water quality treatment for the first flush from the larger watershed. Herbaceous wetland vegetation would be planted in these pool areas to enhance water quality treatment and the forest canopy along the southern margin of each zone would be thinned to increase sunlight for the wetland vegetation.

The efficacy of these enhanced wetland pools in providing water quality treatment for the larger storm events is less certain because there is no sequestration of the water quality volumes above the modest pools as you would find in a constructed wetland. Also, the sequestered water remaining in the pools may not contain only the "first flush" stormwater that most needs treatment. Nonetheless, removing accumulated sediment from the wetland/floodplains could restore some of the natural functions of the wetlands.

This added wetland restoration in zones 2, 3, and 4 would increase the regulated wetland disturbance from 3,800 sf for zone 1 alone, to 5,500 sf for all zones, likely triggering a more rigorous individual permit review by the COE (threshold is 5,000 sf). Such larger impact area within the wetland would also call more attention from the public. Nonetheless, this option deserves more careful consideration. A suboption to consider would reduce the pool sizes so that the COE threshold is not reached.

Under this option, the inlet structure would also be replaced, as needed to receive drainage from Oakledge Park under Options D1-D10.

4 Floodplain Treatment (zones 2-4 = 1,700 sf $ 600 cf), Defer Replacement of Structure

Same as Option 3 except the inlet structure would not be replaced, as suitable for Options D11-D12 to defer costs. Note, the inlet structure is dilapidated and needs to be replaced to ensure proper stream flow. This option also deserves more careful consideration.

5 No Treatment, Replace Inlet Structure

This option would not involve any water quality treatment from the larger stream, but would replace the inlet structure as needed for Options D1-D10. For this reason it deserves more careful consideration.

6 No Treatment, Defer Replacement of Structure

This option would not involve any water quality treatment from the larger stream and would leave the inlet structure as is, as suitable for Options D11-D12 to defer costs. For this reason it deserves more careful consideration.

B Options for Management of Upper Basin Land Uses to Improve Stream Water Quality

1 Manage Land Uses at Source (target AP-1, CSWD-1, and IPW-1)

This option would involve future activities by the City stormwater office and other City departments to motivate private landowners, not currently subject to state stormwater permits, and with high potential for pollutant contributions, to adopt stormwater treatment practices that reduce the potential pollutant load. In particular, treating impervious surfaces to reduce sediment scour and providing best management practices (BMPs) to provide on-site water quality treatment should be encouraged.

The importance of this option is highlighted by the lack of opportunity for on-stream treatment at the Blanchard Beach wetland, as discussed above. For this reason it deserves more careful consideration. A final recommendation on target land uses and storm management options will be included with the final design materials.

Sub-watershed areas OLP-2 and FA-2, including management of drainage from the lower parking area in the park and lower Flynn Avenue, are discussed under Options C1-C2 and D1-D12 below.

2 No Management

This option is simply the null version of Option B1. As this option is contrary to one of the core purposes of this feasibility work, this option was not considered further.

C Options for Treatment of Drainage from Lower Flynn Avenue

<u>1 Direct to Lower Wetland Treatment (see E Options)</u>

This option would continue the existing drainage pattern, where all of the drainage from Lower Flynn Avenue would flow in the gutter along the edge of the new sidewalk to a replacement catch basin, joining any swirl separation treatment of drainage from Oakledge Park (see D Options), and flowing into wetland zone 1 for water quality treatment (see Options E1-E3). This option has minimal issues and should be considered further.

2 Direct to Swirl Treatment

This option would install a separate vortex separation unit buried in the road and then discharge to the stream with no further treatment. While a vortex unit could assist in separation of organic materials from Lower Flynn, additional water quality treatment may be desireable through wetland treatment. Option C1 and C3 would be preferable and option C1 may connect with a vortex unit treating drainage from Oakledge Park. For this reason, this option was not considered further.

<u>3 Direct to Upper Wetland Treatment (zone 3 = 1,500 sf & 1500 cf)</u>

This option would intercept drainage from most of Lower Flynn Avenue above the existing sewer pump station and direct it through a catch basin and pipe to wetland zone 3, the eastern end of the Blanchard Beach wetland. Drainage from Lower Flynn used to drain to this area before the sidewalk was constructed.

If zone 3 is used for this option, two shallow ponds can be excavated from the accumulated sediment as discussed as part of Option A3 above, except that an 18 inch earthen berm would be constructed along the east bank of the stream to sequester a larger water quality treatment volume, similar to Option E2 for wetland zone 1 discussed below.

Assuming the water quality treatment occurs in wetland zone 1 as discussed under Options E1-E3 below, 3,800 square feet of wetland would be impacted. If Option C3 is adopted as well, an additional 1,500 square feet of wetland would be disturbed, likely triggering a more rigorous individual permit review by the COE. Such larger impact area within the wetland would also call more attention from the public. Nonetheless, this option deserves more consideration.

4 Direct to Stream with No Treatment

This option would direct drainage from Lower Flynn Avenue directly to the stream with no treatment. This was not viewed as a feasible option in terms of water quality, as it would reduce the current treatment levels. This option was not considered further.

D Options for Treatment of Drainage from Oakledge Park

Please note that the options listed below are complicated and care must be exercised in reviewing this section. The options involve three basic questions: 1) whether to separate the upper and lower drainage areas in Oakledge Park, 2) how to armor the swale along the entry road, and 3) whether to armor the lower parking lot, add a swirl separation devise, or both.

1-4 Segregate Upper and Lower Drainages, Direct Upper Drainage to Stream with No Treatment

<u>1 Use New CB/Pipe Along Park Road (385'), Armored Parking Lot (20,000 sf) to Swale (420') and Wetland Treat (see Option E)</u>

This option would segregate the upper drainage in Oakledge Park through a new catch basin just before it reaches the swale along the entry road. A pipe (approx 24 inch diameter) would then carry the drainage under the swale, around the corner at Flynn Avenue and discharge into a new inlet structure above the wetland.

Drainage from the lower parking lot and the entry road would collect in the swale, and then discharge into a catch basin and pipe to the wetland zone 1 treatment area. No swirl separation devise would be used. Instead, to reduce the sediment load, the lower parking area would be armored (costed with paving) and the swale along the entry road would be armored with type II stone.

While separating the upper drainage and directing it directly to the stream may have merits, there is more technical complexity and cost associated with more catch basins, piping, and structures. Nonetheless, the option should be considered further.

<u>2 Use New CB/Pipe Along Park Road (385'), Parking As Is to Swale (420'), Swirl, and Wetland Treat (see Option E)</u>

This option is the same as Option D1, except that the lower parking lot would remain as is with no armoring, and instead a swirl separation devise would be added under Flynn Avenue as pre-treatment before discharge into the wetland zone 1 treatment area. The option should be considered further.

<u>3 Use Swale Along Park Road (385'), Armored Parking Lot (20,000 sf) to CB/Pipe (420') and Wetland Treat (see Option E)</u>

This option is the reverse of Option D1, directing the upper drainage to an armored swale extending to the new inlet structure above the wetland. The drainage might need to continue to use the right angle culvert at the corner with Flynn Avenue because of steep slopes and tight property lines. The drainage from the lower parking lot to a new catch basin and 18 inch diameter pipe to the wetland zone 1 treatment area. The parking lot would be armored (costed with paving) and no swirl separation would be used.

While separating the upper drainage and directing it directly to the stream may have merits, there is more technical complexity and cost associated with more catch basins, piping, and structures. Nonetheless, the option should be considered further.

<u>4 Use Swale Along Park Road (385'), Parking As Is to CB/Pipe (420'), Swirl, and Wetland Treat (see Option E)</u>

This option is the same as Option D3, except that the lower parking lot would remain as is with no armoring, and a swirl separation devise would be added under Flynn Avenue as pre-treatment before discharge into the wetland zone 1 treatment area. The option should be considered further.

5-12 Mix Upper and Lower Drainages, Direct All Drainage to Wetland via Swale for Treatment

<u>Armor Parking (20,000 sf), Swale (350'), Swirl, and Wetland Treatment (see E Options)</u>

<u>5 Stone Swale</u>

This option would retain the combined drainages from the park and direct them to the swale along the entry road, then to a swirl separation unit, and then to wetland zone 1 treatment. The swale along the entry road would be armored with type II stone.

Because the combined drainage flows could exceed the treatment capacity of the wetland zone 1 treatment area, the swirl separation unit would be preceeded by a catch basin with a weir that would direct excess flow to the stream through a new inlet structure above the wetland, rather than allowing the wetland zone 1 treatment area to be overwhelmed. The sizing of this bypass event would depend on the final treatment option used in wetland zone 1 (see Options E1-E3).

In addition to the swirl separator, the lower parking area would be armored for maximum sediment removal.

6 Turf Reinforced Swale

This option is the same as Option D5, except the swale along the entry road would be grass lined, but armored with a plastic grid reinforcement such as North American's Vmax3-sc250 permanent turf product. Small stone would also be laid under the lowest portion of the grid where continual wetness makes establishment of turf more challenging.

This option would be visually more appealed than option D5.

Armor Parking (20,000 sf), Swale (350'), No Swirl, and Wetland Treatment (see E Options)

7 Stone Swale

This option is the same as Option D5, except that no swirl separation unit is installed to save on costs. Armoring the lower parking lot and armoring the swale with stone would significantly reduce sediment loads.

8 Turf Reinforced Swale

This option is the same as Option D6, except that no swirl separation unit is installed to save on costs. Armoring the lower parking lot and armoring the swale with reinforced turf would significantly reduce sediment loads.

Parking As Is, Swale (350'), Swirl Separator, and Wetland Treatment (see E Options)

9 Stone Swale

This option is the same as Option D5, except that the lower parking area is not armored to save on costs. Armoring the swale with stone would reduce some of the sediment loads.

10 Turf Reinforced Swale

This option is the same as Option D6, except that the lower parking area is not armored to save on costs. Armoring the swale with reinforced turf would reduce some of the sediment loads.

11 Parking As Is, Stone Swale (350'), No Swirl, and Wetland Treatment (see Option E)

This option would retain the combined drainages from the park and direct them to the swale along the entry road and then to wetland zone 1 treatment. The swale along the entry road would be lined with type II stone, but the lower parking area would not be armored nor would a swirl separation unit be installed.

Because the combined drainage flows could exceed the treatment capacity of the wetland zone 1 treatment area, the wetland zone 1 treatment area would be overwhelmed. For this reason, this option was not considered further.

12 Everything As Is

In this option, drainage from Oakledge Park is not changed. This option was not considered further.

E Options for Wetland Restoration/Stormwater Treatment in Zone #1

<u>1 Floodplain Treatment with High Berm (102') Sequestration (zone 1 = 3,700 sf & 5,700 cf)</u>

This option will treat the stormwater directed to wetland zone 1 through a series of five shallow ponds created by excavating accumulated sediment up to 12 inches deep. erbaceous wetland vegetation would be planted in these pool areas to enhance water quality treatment and the forest canopy along the southern margin of zone 1 would be thinned to increase sunlight for the wetland vegetation.

The ponds alone would detain about 775 cubic feet of water quality volume, which is significantly below the target water quality treatment volume from Oakledge Park and Lower Flynn Avenue of 5,000 cubic feet.

To sequester additional volumes, an earthen berm would be constructed along the southern perimeter of the main stream and the bypass stream channel. If the berm were constructed 30 inches high, to a minimum 102.5 feet, it could hold 5,700 cubic feet up to a water level of 102.0 feet.

During the water quality storm event, the main stream has been modeled to reach an elevation of 100.6 feet adjoining zone 1 and would not be expected to overflow into the zone 1 sequestration area. This sequestration of the water quality treatment volume is a primary objective for a new generation of constructed wetlands (see Virginia study).

This high berm does create greater issues. First, a larger berm close to the stream may be more objectionable to F&W. Second, a larger berm will require more armoring on the stream side to resist larger stream flow in larger storm events. Third, a larger berm will be more noticeable and potentially objectionable to the public. Forth, a larger berm will require more earth to be brought into the site at greater cost.

2 Floodplain Treatment with Low Berm (101') Sequestration (zone 1 = 2,700 sf & 2,600 cf)

This option is the same as Option E2, except the berm would be one foot lower with a water quality volume of 2,600 cubic feet, about half the target volume.

The berm would only be 18 inches tall near should be easier to construct and armor, and could be less visible to the public.

While not meeting the water quality treatment volume is a concern, this could be offset by combining with options that armor the lower parking lot, armor the park roadside swale, and install a swirl separator. In addition, peak flows can be moderated either by a weir/bypass structure before the swirl separator, or by enlarging the orifice of the outlet structure for zone 1. By not allowing the zone 1 treatment area to overflow, the first flush from the park and lower Flynn can best be sequestered and treated in the wetland.

3 Floodplain Treatment with No Sequestration (775 CF)

This option is the same as Options E1 and E2, except no berm is used to sequester a larger water quality volumes. Treatment in the series of shallow pools would be beneficial, but would be easily overwhelmed by larger storm events. This option would be similar in concept to Options A3 or A4 in zones 2, 3, and 4, and would represent a minimal level of stormwater treatment, but provide significant wetland restoration.

Team Recommendation Made in Each Category

Guided by Highest Scores

The Team recommendation is guided first by the matrix scoring which rates Options A6, B1, C1, D4, D6, D10, and E3 as the highest scores. For Options B1 and C1, little additional consideration was needed and these options are recommended.

Guided by Technical Needs The highest scoring options may not reflect the technical requirements of other options that are recommended. While Option A6 is highest scoring, keeping the existing inlet structure makes it difficult to any of the D options that divert stormwater to the inlet structure. Not replacing the inlet structure above the wetland needs to be accomplished, with or without this project. Therefore the Team prefers Options A5 and A3.

Favor Water Quality over Costs

For several options, the highest scoring and technically preferred options may not have the best water quality outcomes. Option A5 scores higher than A3, yet achieves less of the overall water quality (and wetland restoration) objectives. For this reason, the Team recommends BOTH Options A3 and A5, even though Option A3's higher cost results in a lower score.

Likewise, Option E3 with no berm around the zone 1 treatment area had the highest overall score because of lower costs, but was rejected because it had significant water quality shortfalls by not sequestering the treatment area from the larger stream flows. The next highest score was Option E2 which is the Team recommendation.

Also similar, Option D6 was the Team recommendation over equal scoring Options D4 and D10 because of better water quality results, yet higher costs.

Final Team Recommendations

Team Recommendation 1 is for the combination of Options A3, B1, C1, D6, and E2. Recommendation 1 is reflected in one of the attached conceptual plans. This recommendation maximizes the wetland restoration performed in the wetland, while providing a high level of water quality treatment for the combined storm flows from Oakledge Park and lower Flynn Avenue. Note that if the addition of soil removal in zones 2, 3, and 4 creates excessive problems with the Corps of Engineers, the size of the shallow ponds excavated in these zones could be reduces to a level more acceptable to the COE, or that at least makes the COE review process less cumbersome.

Team Recommendation 2 is for the combination of Options A5, B1, C1, D6, and E2. Recommendation 2 is reflected in the second set of attached conceptual plans. This recommendation limits the wetland restoration only to zone 1, should this be the preference of the COE or F&W.

Construction Cost Breakdown Provided for Each Option

The construction costs for the recommended options are:

Option A3 $16,000 ($6,000 for the new inlet structure from non-project accounts)

Option A5 $6,000 ($6,000 for new inlet structure from non-project accounts)

Option B1	$0 (does not reflect future costs to private landowners)
Option C1	$0
Option D6	$55,550 ($30,000 for the armoring the lower parking lot from non-project accounts)
Option E2	$20,250
General Conditions & Contingency	$18,360
Total Cost Recommendation 1	$110,160 ($36,000 non-project accounts)
Total Cost Recommendation 2	$100,160 ($36,000 non-project accounts)

Please note that the estimated construction costs are approximate costs and have not been put to bid. The estimated costs could also change as a final design if prepared.

	WQv (AF)	WQv (CF)	TSS (lbs)	TP (lbs)	TN (lbs)
OLP1	0.02	871	73	0.28	3.79
OLP2	0.042	1,830	493	0.82	7.41
OLP3*	0.073	3,180	298	0.91	13.02
OLP4*	0.159	6,926	747	1.67	26.22
FA1	0.029	1,263	313	0.91	4.86
FA2	0.023	1,002	389	1.24	3.18

*Assume full treatment given downstream conditions

Target Volume/Loadings		**4,966**	**1268**	**3.25**	**19.24**

Blanchard Beach Wetland Restoration Feasibility Matrix (FINAL)

Options	Score	Tech	Reg/Env	WQ	Cost	Percep	Construction Cost: Project	Construction Cost: Other City	Construction Cost: Other Pvt	Notes for scores <4
On-Stream WQ Treatment										
A3	$\boxed{11}$	4	2	2	1	2	10000	6000	0	may trigger COE, miss first flush, digging & structure cost, work in more wetland
A4	13	4	2	2	3	2	10000	0	0	may trigger COE, miss first flush, digging cost, work in more wetland
A5	$\boxed{15}$	4	4	1	2	4	0	6000	0	no WQ gain, structure cost
A6	17	4	4	1	4	4	0	0	0	no WQ gain
Upper Basin Land Use Management										
B1	$\boxed{18}$	2	4	4	4	4	0	0	???	private activities hard to control
Lower Flynn WQ Treatment										
C1	$\boxed{18}$	4	4	3	4	3	0	0	0	competes for WQ volume, work in wetland
C3	13	3	2	4	2	2	6550	0	0	misses lowest section, trigger COE, work in more wetland
Oakledge Park WQ Treatment										
Drainage Separated										
D1	16	4	4	3	1	4	19800	30000	0	(requires A3 or A5) pipe, less WQ, & pave cost
D2	16	4	4	2	2	4	37800	0	0	(requires A3 or A5), less WQ, pipe & swirl cost
D3	16	4	4	3	1	4	12600	30000	0	(requires A3 or A5), less WQ, smaller pipe & pave cost
D4	17	4	4	2	3	4	30600	0	0	(requires A3 or A5), less WQ, smaller pipe & swirl cost
Drainage Mixed										
D5	16	4	4	4	1	3	7550	30000	0	(requires A3 or A5) pave & swirl cost, stone swale less appealing
D6	$\boxed{17}$	4	4	4	1	4	25550	30000	0	(requires A3 or A5) pave & swirl cost
D7	14	4	4	2	1	3	7250	30000	0	exceeds WQ volume, pave cost, stone swale less appealing
D8	15	4	4	2	1	4	7250	30000	0	exceeds WQ volume, pave cost
D9	16	4	4	2	3	3	25250	0	0	(requires A3 or A5) exceeds WQ volume, swirl cost, stone swale less appealing
D10	17	4	4	2	3	4	25250	0	0	(requires A3 or A5) exceeds WQ volume, swirl cost
Zone #1 Wetland Treatment										
E1	11	3	2	4	1	1	25750	0	0	hard to armor berm, stream proximity, digging & lg berm cost, even more work in wetland
E2	$\boxed{14}$	4	3	3	2	2	20250	0	0	stream proximity, missing WQ volume, digging & berm cost, more work in wetland
E3	15	4	4	1	3	3	17750	0	0	min WQ volume, digging cost, work in wetland
Recommended Options (A3, B1, C1, D6, E2)							55800	36000	???	
Recommended 2 Options (A5, B1, C1, D6, E2)							45800	36000	???	

Add 20% to estimated costs for general conditions and contingency

Estimated costs are approximate and subject to change with additional information

Reasoning for recommendations:

A5 recommended over A6 because D3 & D4 were selected, and because lack of WQ can be offset by B1

A3 also recommended because it restores more wetland, but does not treat first flush in stream and may trigger COE jurisdiction

B1 was the only choice considered

While C1 competes for limited WQ volume, C3 will definitely triiger COE and cannot capture the lowest section of road

While any of D options can work, D4, D6, and D10 were best scores, but D6 had better WQ treatment, albeit at a higher cost

E2 recommended over E3 because of importance of WQ objective

BLANCHARD BEACH WETLAND RESTORATION FEASIBILITY ANALYSIS
ALL OPTIONS CONSIDERED
PARKING AREA

30 0 15 30 60

FEBRUARY 17, 2012

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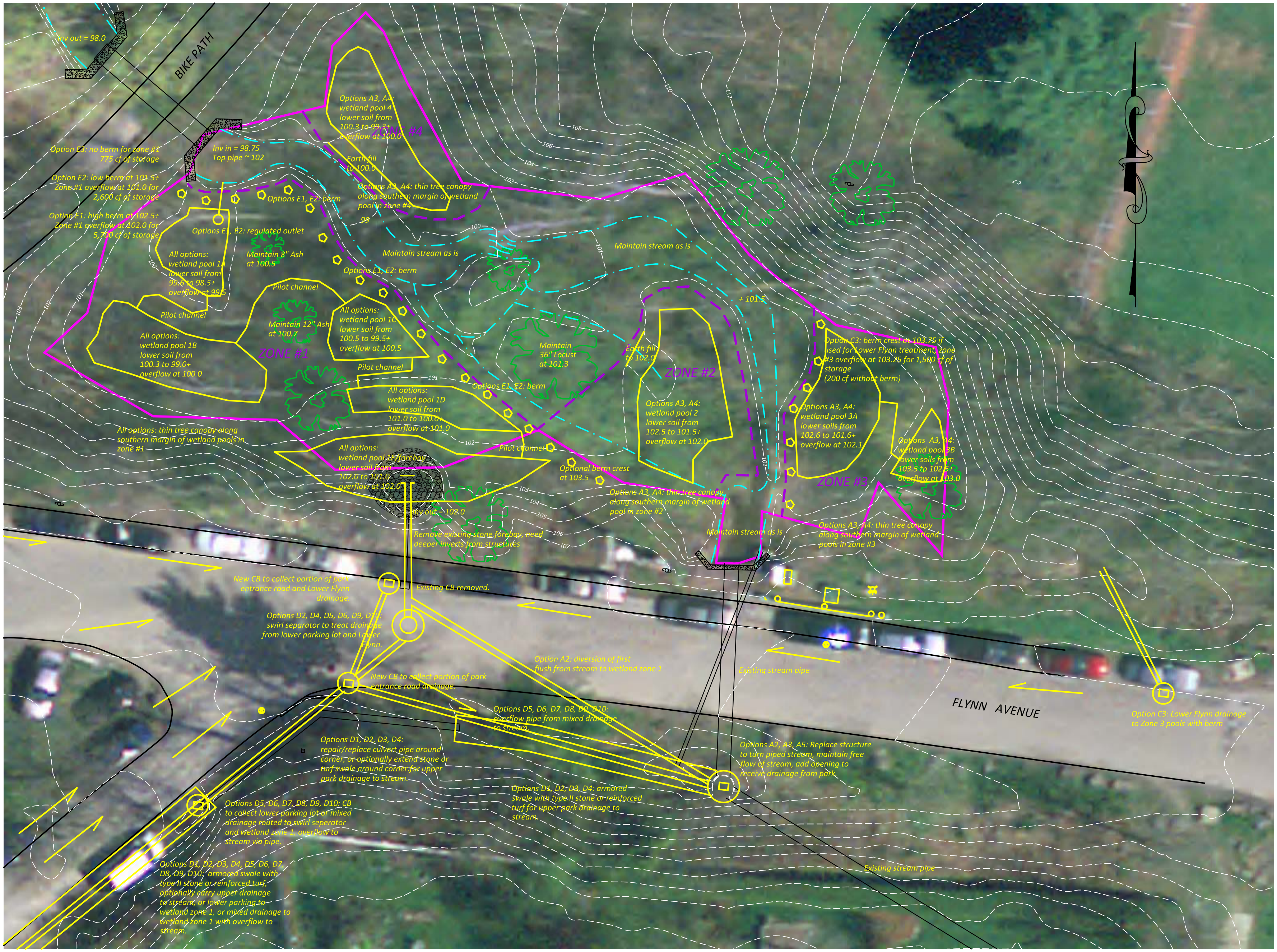

BLANCHARD BEACH WETLAND RESTORATION FEASIBILITY ANALYSIS
ALL OPTIONS CONSIDERED
WETLAND AREA

FEBRUARY 17, 2012

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